

THE CLASSIFICATION OF THE MITE FAMILIES TROMBELLIDAE AND JOHNSTONIANIDAE AND RELATED GROUPS, WITH THE DESCRIPTION OF A NEW LARVA (ACARINA: TROMBELLIDAE: *NOTHROTROMBIDIUM*) FROM NORTH AMERICA

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Summary

SOUTHCOTT, R. V. (1987) The classification of the mite families Trombellidae and Johnstonianidae and related groups, with the description of a new larva (Acarina: Trombellidae: *Nothrotrombidium*) from North America. *Trans. R. Soc. S. Aust.* **111**(1), 25-42, 29 May, 1987.

Amongst the Trombidoidea an unnamed family group containing Trombellidae, Chyzeriidae and Audyanidae fam. nov. is recognized: these families are defined and keys provided for the larvae of the families, subfamilies and genera. The Johnstonianidae is examined, and three new subfamilies, Terrathrombiinae, Pteridopodiinae and Ralphaudyninae are established, with *Ralphaudyna* Vercammen-Grandjean *et al.*, 1974 being transferred to the Johnstonianidae.

*Ralphaudyna amamiensis* Vercammen-Grandjean, Kumada, Newell, Robaux & Suzuki is recorded from a second Japanese location, as an ectoparasite on the gryllaeridoid *Tochymenes robustus* Ander (Orthoptera, Rhaphidophoridae). Further metric and descriptive data are given for this larval mite.

*Nothrotrombidium treati* sp. nov., larva (Acarina: Trombellidae) is described from a single specimen found dead on a noctuid moth *Spaelotis clandestina* (Harris) (Lepidoptera: Noctuidae) at Tyringham, Mass., U.S.A.

This is the first record of this genus in North America, previously recorded from Europe and South America, as well as Madeira, in the Atlantic Ocean, and Asia.

KEY WORDS: Taxonomy, *Nothrotrombidium*, *Ralphaudyna*, larva, North America, Japan, Acarina, Trombidoidea.

Introduction

The Johnstonianidae and the Trombellidae are accepted by some workers as the most primitive families of the Trombidoidea. In the case of the Johnstonianidae this opinion is based on the presence of a number of supposedly primitive morphological, behavioural and ecological characters (Newell 1957). Thus there are two pairs of sensilla on the scutum, crista or equivalent areas in most species, resembling the situation in the Erythraeoidea, but with loss or modification of the anterior pair in some genera. Other supposedly primitive characters are the simplicity of body setae, the presence of larger than usual numbers of sensory setae on various leg segments, and the general lack of reduction of leg segmentation, as well as the presence of various specialized setae on the gnathosoma. Some larvae are apparently predatory, while others are, as in the majority of the trombellids, ectoparasitic upon arthropods. Newell (1957) has also stressed the "self-detaching" character of the larvae in response to stimuli, for example when the host with its larval ectoparasites is immersed in preserving fluids. There is also, among the adult as well as the larval johnstonianids, a sensitivity to heat and desiccation (Newell 1957, 1960).

The Trombellidae (which have only one pair of prodorsal sensilla) possess a number of similar characters: The adult leg segmentation is not reduced, and in the larvae the legs usually carry more sensory setae than other trombidooids. The larval coxae tend to be separated, and the urstigma may not be strongly associated with coxa I. The concept of the Trombellidae as primitive may be based more on a general resemblance to the Johnstonianidae than on more specific indications.

Variant views are expressed by other workers. Thus Feider (1959b) gave an illustration hypothesizing that the "Tanaupodidae" and "Calothrombiidae" are the two most primitive families of the Trombidoidea, originating from a common branch, while the next branch, at a slightly higher level, gave rise to the Johnstonianidae and "Nothrombiidae". On the other hand, Vercammen-Grandjean *et al.* (1973) considered that the families Trombellidae and Leewenhoekiidae are more primitive than other "close families, such as the Johnstonianidae . . .".

Thus the phylogeny of these mites remains a matter of contention (an equivalent situation occurs in the Erythraeoidea — see Southcott 1961a).

Thor (1935) divided the family Trombellidae Leach, 1815 (Trombidoidea of this paper) into 10 subfamilies, many of which have later been accorded family status. Among such were the Johnstonianinae and the Trombellinae, the latter

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defined as follows: Body elongate. Abdomen rectangular. Skin hard/firm ("hart"), rough/uneven ("höckerig"), hairs short, pointed. Crista lacking; the two sensory hairs sit close together in the middle of the thorax in two thick tubercles between the two sessile eye pairs. The fourth palpal segment with differing spines or hairs; fifth segment long.

Only the type genus *Trombella* Berlese, 1887, is included (translation R.V.S.). There was no reference to the larvae, as then unknown. The adult genus *Chyzeria* Canestrini, 1897 was omitted.

Feider (1958b) described the larva of the trombellid mite *Nothrotrombidium otiorum* (Berlese, 1902), stating that this was the first genus in the family for which there was correlation between larva and adult. However, two genera, *Chyzeria* (see Womersley 1939) and *Audyana* (see Womersley 1954a,b), had previously been correlated between the larva and the adult or deutonymph. These rearings allowed some attempts to define the characters of the larval Trombellidae (Vercammen-Grandjean *et al.* 1974; Southcott 1982). Following a correlation of an Australian *Trombella* larva with its deutonymph, the classification of the Trombellidae has been developed further (Southcott 1986a).

*Nothrotrombidium* was founded by Womersley (1954b), with type species *Trombella otiorum* Berlese, 1902 from Europe. In the genus he placed also *T. nothroides* Berlese, 1888 from South America, and *T. lundbladi* Willmann, 1939, from Madeira. A further species, *N. brevitarsum* André, 1960, has been described from Nha Trang, Indochina. All of these were adults.

In this paper a second larval species of *Nothrotrombidium*, *N. treati* sp. nov., is described from a noctuid moth in North America. This discovery prompts a further examination of the characters of the Trombellidae and related trombidoid mites.

## TAXONOMIC DECISIONS AND ACCOUNTS

In the most recent reviews of the Trombellidae, Southcott (1982, 1986a) included the following genera: *Trombella*, *Chyzeria* Canestrini, 1897, *Womersleyia* Radford, 1946, *Nothrotrombicula* Dumbleton, 1947, *Audyana* Womersley, 1954, *Nothrotrombidium* Womersley, 1954, *Durenia* Vercammen-Grandjean, 1955, *Parathrombella* André, 1958, *Neonothrotrombidium* Robaux, 1968, *Ralphaudyna* Vercammen-Grandjean *et al.*, 1974 and *Malputrombella* Southcott, 1986. Of these *Trombella*, *Chyzeria*, *Durenia*, *Audyana* and *Nothrotrombidium* are known both as larvae and adults or deutonymphs; *Womersleyia*, *Nothrotrombicula* and *Ralphaudyna* are known only

as larvae, and *Parathrombella*, *Neonothrotrombidium* and *Malputrombella* are known only as adults.

Southcott (1986a) excluded *Parachyzeria* Hirst, 1926, from the Trombellidae, and placed it in the Johnstonianidae.

Vercammen-Grandjean (1973) placed six subfamilies to the Trombellidae: Trombellinae, Tanaupodinae, Calothrombiinae, Spelaethrombiinae, Notothrombiinae and Moyanellinae. He gave no reasons for these decisions, which may have stemmed largely from the difficulties of placing groups with which he was relatively unfamiliar. A well-marked crista is present in the adults of the Tanaupodinae, Calothrombiinae and Spelaethrombiinae, so there appears no reason to associate them with the Trombellidae, Chyzeriidae and Audyanidae. In *Notothrombium* Storkán, 1934 (the sole genus of the Notothrombiinae) and in *Moyanella* Boshell & Kerr, 1942 (the sole genus of the Moyanellinae) the crista of the adults is poorly defined or absent; both have two pairs of prodorsal sensilla (see Thor & Willmann 1947; Robaux 1967); thus it appears that their affinities lie more with the Johnstonianidae rather than the Trombellidae, and they are here considered as being part of the Johnstonianid family group, possibly deserving family status. As the larva of neither of these two families is known, however, they will not be considered further here.

A difficulty in the classification of the Trombidioidea (and other Parasitengona) is caused by the extreme heteromorphy which exists between the larvae and the adults (or deutonymphs), causing dual generic and specific names for the hexapod and octopod instars, as well as difficulties in taxonomic placements, failing accurate correlations. One such instance is as follows.

*Ralphaudyna* Vercammen-Grandjean *et al.*, 1974 was placed by its authors in the tribe Chyzeriini of the Trombellinae (=Trombellidae of this paper). The genus was erected for a single specimen of *R. amamiensis* Vercammen-Grandjean *et al.*, 1974, obtained in "soil under an olden tree cave on the middle slope of Mt Yuwan-dake ... Amami-oshima Island", Japan, and hence from an unknown host, or potential host, arthropod. They laid stress upon the "presensillae" of the dorsal idiosomal scutum, and therefore considered it a link between "the two groups *Chyzeria* ... and *Parachyzeria*". However, the larva of *Parachyzeria* has not been described. The placing of *Ralphaudyna* in the Trombellinae was accepted by Southcott (1982, 1986a).

Further specimens of *Ralphaudyna amamiensis* have been found at a second locality in Japan, taken parasite on a gryllacridoid (Orthoptera) (see p. 38).

Examination of these specimens shows that the "presensillae" or "presensilla" are close to typical scutal trichobothria, placed more posteriorly on the scutum, although smaller. The only possibly important difference between the anterior and posterior trichobothria lies in the anterior ones having a somewhat thickened shaft for the whole of the sensillary seta. *Ralphaudyna* was placed in the Chyzeriini of the Trombellinae by its authors rather than in the Johnstonianidae principally on this character, and because it is "provided with a very wide nasus. Several nude genualae on each leg."

As far as the presence of "presensilla" is concerned, Newell (1958) used this term as "presensillar setae" but without definition; in 1960 he defined a term "presensillum" to apply to paired anteromedian scutal setae of Trombiculidae, Johnstonianidae and Trombidiidae. The presence of such setae, if one accepts Newell's concept, is not a definitive character for any particular member of the three families nominated. Newell in fact stated (1960) that the term "presensillum" could be applied in many Trombiculidae to the unpaired anteromedian scutal seta.

A prominent, even wide, nasus had been described in various larvae of the Johnstonianidae, e.g. in *Diplothrombium* Berlesè, 1910 by Newell (1957), Feider (1959a), in *Centrotrombidium* Kramer, 1896 by Newell (1957), and in other genera.

Accepting the term "genuala" as applying to any nude sensory seta on the leg genu (and excluding the vestigiogenualae) such setae are absent in *Chyzeria* and *Nothotrombicula*, but are present in *Trombella* and *Nothrotrombidium* (Vercaemmen-Grandjean 1972; Southcott 1982, 1986a) as well as in the Johnstonianid genera *Lassenia* Newell, 1957, *Diplothrombium* and others (see Newell 1957).

None of the criteria advanced by Vercaemmen-Grandjean *et al.* (1974) for the exclusion of *Ralphaudyna* from the Johnstonianidae and its placement in the Trombellinae (Trombellidae) is sustained.

Thus, *Ralphaudyna* is removed from the Trombellidae, and placed in the Johnstonianidae, in *Ralphaudyninae*, subfam. nov.

Kranz (1978), following advice (*in lit.*) from Vercaemmen-Grandjean, has used the family term Chyzeriidae (as Chyzeridae), separating it by key characters from Trombellidae. Here I define the Chyzeriidae and a restricted family Trombellidae.

Seta and scutal terminology follows Southcott (1961a,b, 1963, 1986a,b).

Superfamily Trombidoidea Leitch

Partial synonymy

Trombidoes Leach 1815, pp. 387, 395.

Trombidiidae Michael 1884, pp. 4, 138 (ad p.); Thor & Willmann 1947, p. 187.

Trombidiinae Michael 1884, p. 50.

Trombidoidea Banks 1894, p. 209; Southcott 1957a, p. 173; 1982, p. 285; Vercaemmen-Grandjean 1973, p. 109; Welbourn 1983, p. 403; 1984, p. 335.

Trombidia Feider 1959b, p. 539; 1979, p. 420.

*Definition:* Prostigmatic mites of generally ovoid or elongate form in post-larval deutonymphal and adult (octopod) stages. With one or two pairs of dorsal propodosomal sensillary setae in all mobile stages; generally in association with a crista or shield in octopod stages, but crista and shield may be rudimentary, obsolete or absent. Larva generally rounded, hexapod, with one or more dorsal idiosomal shields, sensillary setae (one or two pairs) borne by anteromost shield. Gnathosoma well developed in all mobile stages, with mobile digits as hinged blades, not retractile, not styliform. Octopod states generally with genital acetabula (suckers). Coxae I and II, and III and IV, contiguous on each side in octopod stages, I and II generally contiguous in larvae, but may be separate in larvae. Larvae heteromorphic to octopod stages. Larva with urstigma and anus. Octopod stages predatory upon small arthropods. Larvae generally parasitic upon invertebrates and vertebrates. Mites never fully aquatic.

Type genus *Trombidium* Fabricius, 1775.

*Remarks:* The larvae of the Trombellidae and Johnstonianidae may have one or more of the following characters:

- (1) coxae usually separated and urstigma usually separated from coxa I
- (2) idiosomal setae usually arise from expanded basal plates
- (3) usually many sensory setae on the femora and genua of the legs.

Two family groups may be distinguished among these larvae, as follows:

Dorsal shield well developed, with 6 or 8 setae, including one pair of sensillary setae, well developed, but never clavate or thickened. Coxae of legs separated. Urstigma attached to posterior margin of coxa I. Supracoxalae present or absent. Palpal tibial claws generally well-developed, bifurcate or trifurcate . . . . .

..... Trombellidae family group

Dorsal shield present, with eight setae, but may be only moderately sclerotized; a small separate anterior part may be present. Generally two pairs of scutal sensillary setae (one pair only, in one genus), of which one pair may be enlarged in central part, or even clavate. Anterior pair of sensillary setae and their alveoli may be rudimentary. Coxae I and II may be joined or separate on each side. Urstigma usually free of coxa — may project laterally between the coxae, or be attached to the anterior border

of a separate coxa II (*Leptothrombium*). Supracoxalae present or absent. Palpal tibial claws generally small, bifurcate or with a single claw, or may be replaced by elongate setae, not claw-like.

Family *Johostominae* (as yet considered a single family, with several subfamilies, as far as knowledge of the larvae is concerned).

As can be seen, there are many shared characters between the two groups. Nevertheless, at the family level there is rarely difficulty in placement.

**Trombellidae family group**

The Trombellidae family group here includes the Trombellidae, Chyzeriidae and Audyanidae, *fam. nov.* These are separated as follows:

**Key to the larvae of the Trombellidae family group**

- 1. AM setae lacking. Dorsal propodosomal scutum with 6 setae. Leg segmental formula 7, 7, 7. Pedotarsal claws 3, 3, 3. Palpal tibial claw trifurcate. Lateral surface of cheliceral blade with many fine teeth. Supracoxalae present. Eyes 2 + 2 ..... *Chyzeriidae*
- AM setae present. Dorsal propodosomal scutum with 8 setae. Leg segmental formula 6, 6, 6 or 7, 6, 6. Pedotarsal claws 1, 1, 1 or 1, 1, 2 or 3, 2, 2. Palpal tibial claw bifurcate. Lateral surface of cheliceral blade smooth, normal. Supracoxalae absent. Eyes 2 - 2 or absent ..... *Trombellidae*
- 2. Leg segmental formula 6, 6, 6. Pedotarsal claws 1, 1, 1 or 1, 1, 2. None of scutal setae short and clavate. Coxalae and palpfemorals normal, setulose. Eyes 2 ..... *Trombellidae*
- Leg segmental formula 7, 6, 6. Pedotarsal claws 2, 2, 2. Some of scutal setae short and clavate, also coxalae II and III, and palpfemorals. Eyes absent ..... *Audyanidae*

**Family Trombellidae**

**Partial synonymy**

- Trombellinae* Thoir 1935, p. 108; Womersley 1937, p. 75; 1954a, p. 117; 1954b, p. 121. Vercaemmen-Grandjean 1973, p. 109. Vercaemmen-Grandjean *et al.* 1974, p. 245.
- Trombellidae* Feider 1955, pp. 50, 67; 1979, pp. 421, 422. Southcott 1982, p. 289; 1986a, p. 145.
- Thrombellinae* (sic) André 1960, p. 315; Robaux 1968, p. 453. (all ad p.).
- Thrombellidae* Robaux 1973, p. 124.
- Trombelloidea* Feider 1979, pp. 421, 422 (ad p.) (nom. nud.).

**Redefinition:** Adult and deutonymph: Trombidioida in which the propodosoma either lacks a crista or has only a rudimentary crista; one pair of sensillary setae (trichobothria). Eyes 2 + 2, sessile. Idiosoma may bear large plaques, which may be arranged in columns on upper surface of idiosoma. Idiosoma not attenuate or waisted.

Larva: Trombidioida with one dorsal propodosomal scutum, which projects anteriorly to a narrowed extension or nasus. Dorsal scutum with eight setae, comprising 2 AIs, 2 PIs, 2 AMs, and 2 well-separated sensillary setae, placed between AIs and PIs. Eyes 2 - 2. Leg segmental formula 6, 6, 6. Coxae separated. Pedocoxal formula 2, 1, 1 or 1, 1, 1. Pedotarsal claws 1, 1, 1 or 1, 1, 2. Supracoxalae absent.

Type genus *Trombella* Berlese, 1887.

**Remarks:** The Trombellidae, as restricted, includes all the genera listed earlier (above) for the family, except *Chyzeria*, *Nothotrombicula*, *Audyana* and *Ralphautlyna*. The larvae of remaining genera may be separated as in the following key:

**Key to larvae of Trombellidae**

- 1. Pedotarsal claws 1, 1, 1. Claws simple ..... 2
- Pedotarsal claws 1, 1, 2 (in 1 and 11 the single claw is apically trifurcate) ..... 3
- 2. Chelicerae compact, the combined chelobases about as long as wide. Scutal sensilla generally well behind the level of AL scutalae ..... *Trombella* Berlese
- Chelicerae elongate, the combined chelobases about twice as long as wide. Scutal sensilla only a little behind level of AL scutalae ..... *Nothotrombidium* Womersley
- 3. Nasus of scutum small, largely occupied by the bases of the AM scutalae, and with a deep constriction behind. Leg tibia III with a large solenoidala ..... *Womersleyia* Radford
- Nasus of scutum large, triangular, its lateral borders continuous with anterolateral borders of scutum, with at most only minor constriction. Leg tibia III without a large solenoidala ..... *Durenia* Vercaemmen-Grandjean.

***Nothotrombidium* Womersley, 1954**

Redefinition of larva: Trombellidae. Sensillary setae arise behind middle of scutum, a little behind level of AL scutalae. Coxal setal formula 1, 1, 1. Pedotarsal claws 1, 1, 1. Chelicerae bases long and slender; combined chelicerae bases about twice as long as wide. Palpi long and slender, palpal tibial claw small, with two minute terminal nearly apposed prongs.

Type species *N. otiorum* (Berl.) (adult).

***Nothotrombidium treati* sp. nov.**

FIGS 1 A-E; 2 A-C; 3

"Larva of undetermined genus", Treat (1975, p. 236). *Holotype* (in American Museum of Natural History) mounted in Hoyer's medium, identification ACB760, somewhat damaged, found dead "under right forewing of *Spaelotis clandestina* [(Harris)] 68-39 ♂ [Lepidoptera, Noctuidae] "Tyringham, Mass[achusetts], U.S.A., 17 Sept. 1968. A. E. Treat ... (31: 29)", taken 10.10 p.m.



TABLE 1. *Metric data of two species of larval Nothrotrombidium.*

	LN*	AW	PW	SR	ASB	PSB	L	W	
<i>N. treati</i> sp. nov. Holotype	36	47	62	15	78	44	122	76	
<i>N. otiorum</i> (Beck.) (from Feider, 1958b)							90-109	61	
<i>N. treati</i>	AP 35	AM 16	AL 16	PL 29	AMB 14	SE 98	DS 33-62	MDS 38-49	PDS 48-53
<i>N. treati</i>	TrochI	Tel	Gel	Ti	Tal	TrochII	TelII	TelII	
<i>N. otiorum</i>	50	100	55	93	151	50	100	100	
<i>N. otiorum</i>	44	116	58	122	160	41	122	122	
<i>N. treati</i>	GelI	TilI	TalI	TrochIII	TelIII	GelIII			
<i>N. otiorum</i>	52	83	125	64	118	62			
<i>N. otiorum</i>	58	100	136	61	145	67			
<i>N. treati</i>	TilII	TalII	Tal/Gel	Til/GelII	TilII/GelII	TilII/GelII			
<i>N. otiorum</i>	145	146	1.69	1.60	2.34	2.34			
<i>N. otiorum</i>	188	160	(2.10)	(1.72)	(2.81)	(2.81)			

\* LN = distance from anterior tip of scutum to level of the AM setae (see Southcott 1896b).  
† Omitting claws and pedicle of the tarsi.

*Description of holotype larva:* Colour in life not available; the specimen was found dead by Dr A. E. Treat (see Treat 1975, p. 236), who advises (pers. comm. 1983) that the dead mite was orange.

Length of idiosoma (partially engorged) 390  $\mu$ m, width 255  $\mu$ m; total length of animal from tip of chelae bases to posterior pole of idiosoma 485  $\mu$ m.

Dorsal scutum ovoid, narrower anteriorly, lateral and posterior margins somewhat flattened, but generally smoothly rounded.

Scutal scobalae as in definition; scutal sensilla behind middle of scutum, a little posterior to AL scutalae, somewhat separated from each other; scutalae tapering, short, with slight setules.

Metric data are as in Table 1.

Eyes 2 + 2, sessile, each lateral pair set on oval plate, separated from dorsal scutum, and placed between levels of AL and PL scutalae in specimen. Corneae oval, anterior 13  $\mu$ m in longest diameter, posterior 15  $\mu$ m.

Dorsal idiosomal setae slender, tapering, slightly blunted at tip, with minute setules; arising from normal seta-bases (annuli); arranged 6, 6, 6, 6, 5, 2, total 31.

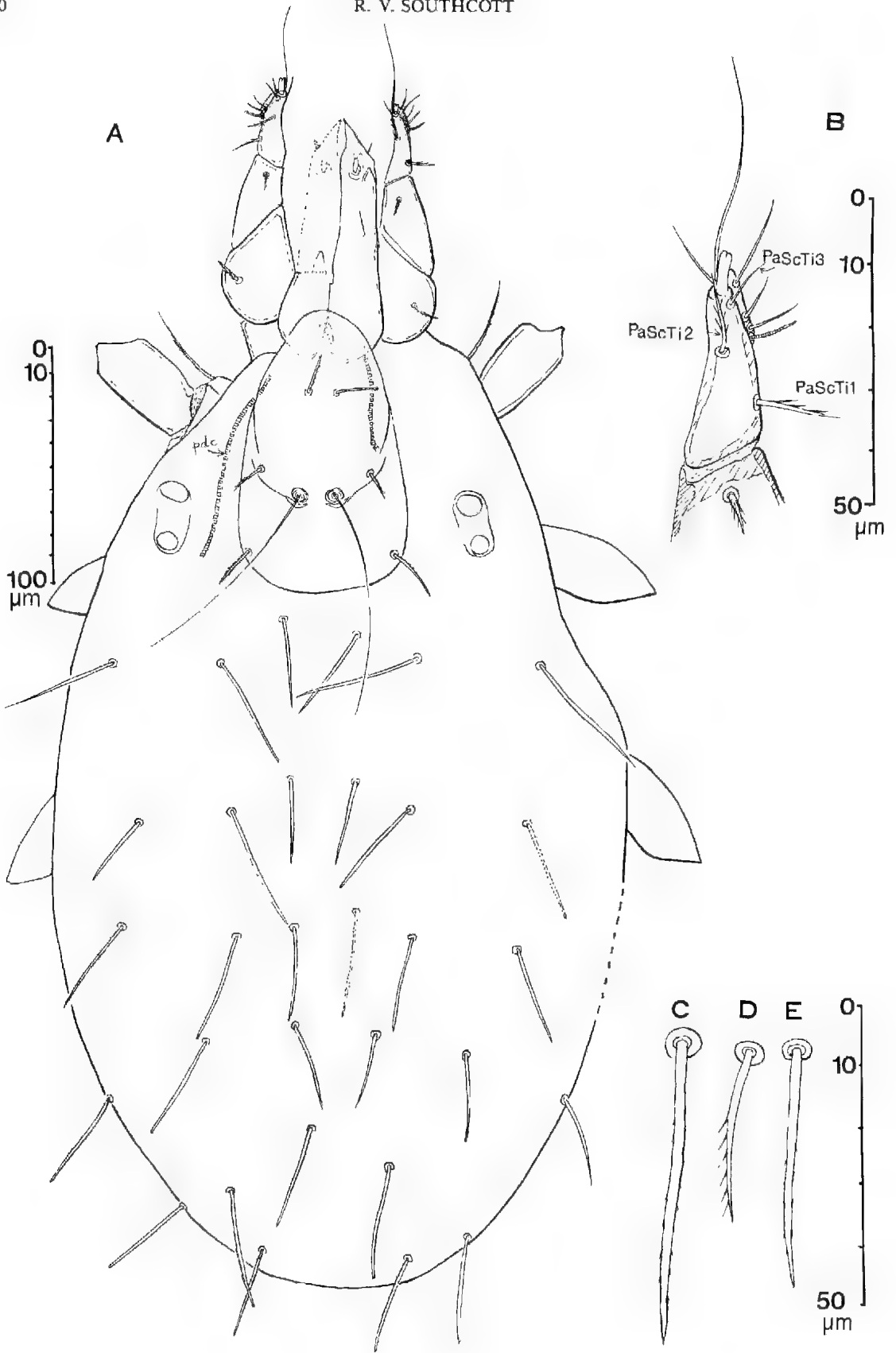
Venter of idiosoma with coxa I and II moderately separated on each side. Sternal area with a pair of scobalae, between coxae II, slender, tapering, pointed, with small setules, 31  $\mu$ m long. Between coxae III a further pair, similar, 33  $\mu$ m long, but with slightly more outstanding setules. Behind level of coxae III are 38 setae, slender, tapering, in irregular transverse rows, 15-49  $\mu$ m long, lengthening posteriorad; the more anterior of these similar to the last-named pair, more posteriorad becoming smoother, similar to the posterior dorsal

idiosomalae. Anus (uroporus) 35  $\mu$ m long by 9  $\mu$ m wide, with two slender valves and a crumpled lip.

Coxalae I, 1, 1, Coxala I arises near AL angle of coxa, slender, tapering, pointed, with faint setules, 47  $\mu$ m long. Coxala II arises anterior and lateral to central point of coxa, similar to I, 36  $\mu$ m long. Coxala III arises anterior to centre of coxa, similar to I and II with adpressed setules, 32  $\mu$ m long.

Leg segmental formula 6, 6, 6. Legs long and slender; femoral to tibial segments more or less cylindrical; tarsi elongate, spindle-shaped. Leg I 510  $\mu$ m long, II 445  $\mu$ m, III 595  $\mu$ m (lengths include coxae and claws). Pedocoxal supracoxala absent. Tarsus I 151  $\mu$ m long by 20  $\mu$ m high where thickest, II 125  $\mu$ m  $\times$  20  $\mu$ m, III 146  $\mu$ m  $\times$  18  $\mu$ m (lengths exclude claw and pedicle). For other measurements, see Table 1. Tarsi bear small, falciform, simple, slender, single claws (in specimen broken in R leg II, missing in I, leg II).

Chaetotaxy of legs: leg scobalae (normal setae) slender, tapering, pointed, with light setule formation. Setae of leg segments are indicated in Fig. 3. A number of specialized setae present on leg segments, in addition to scobalae, distal to trochanters. These include a number of spinalae (eupathidalae). These and other leg setae are identified in Fig. 3 as far as possible, but since, in the damaged specimen only three reasonably complete legs were available (L leg I, R legs II and III), it has not been possible always to identify them; in a number of cases only the setae bases remain. Vestigiogenualae present: VsGel.85pd (7  $\mu$ m long), VsGelII.84pd (6  $\mu$ m). Vestigiotibialae: V5Til.86d (7  $\mu$ m). Solenotarsalae are present to I and II; total, 10d



(37  $\mu\text{m}$ ), SoTaII.18d (22  $\mu\text{m}$ ); famulus is present to I and II: FaTaI.36d (4  $\mu\text{m}$ ), FaTaII.36d (4  $\mu\text{m}$ ), (Tarsal lengths measured to origin of pedicel; for explanation of coding symbols see Southcott 1961a,b, 1963).

Gnathosoma (damaged in specimen, part of one chela missing) small, elongate, combined chelae bases to origin of cheliceral digit (blades broken or missing) 84  $\mu\text{m}$  long,  $\times$  47  $\mu\text{m}$  across, elongate-pyriform. Galeala present, pointed, smooth, 11  $\mu\text{m}$  long. Anterior hypostomala apparently absent. Palpal setal formula 0, 1, 1, 3, 8; palpal coxala ("capitular seta") apparently absent. Palpal supracoxala absent. Palpfemorala dorsal in position, short, pointed, with few setules, about 15  $\mu\text{m}$  long (? broken). Palp genuala similar, dorsal and distal, ca 10  $\mu\text{m}$  long. Palpal tibialae and tarsalae as figured. Palpal tibial claw small, slender, with only a slight cleft and two minute ventrally directed prongs.

*Remarks:* The larva was found "on a ventral axillary membrane of the right wing" of the moth, which had been taken at light. However, the mite has only one dorsal scutum. The idiosoma contains a mass of fungal hyphae (Treat 1975). "The mite's legs were whitish . . . the mounted mite showed a clump of mold mycelia with fruiting bodies on one side of the idiosoma. This was white in the fresh, unmounted specimen." (Treat pers. comm. 1983). (The pallor of the legs is consistent with partial drying of the mite.)

The body of the mite contains fungal elements consisting of hyaline septate hyphae with numerous intercalary chlamydospores. No fruiting bodies are visible in the mounted specimen. Whether the fungal infection occurred before or after the death of the mite cannot be determined, but the latter is considered more likely. The fungus is placed in the Fungi Imperfecti (G. Kominski & D. Ellis pers. comm.).

*Nothrotrombidium* is the only trombellid larva in which the chelicerae are elongate; presumably this character has some adaptive value, if the finding of a *N. treati* larva on a lepidopteran indicates some advantage in burrowing through deep layers of scales.

#### *Taxonomic position of N. treati*

The two known species of *Nothrotrombidium* larvae may be separated as follows:

- 1a TII/Ge I > 2; about 29 ventral setae behind coxae III. . . . . *N. oliorum* (Berl.)  
 1b TII/GeI < 2; about 38 ventral setae behind coxae III. . . . . *N. treati* sp. nov.

*Remarks:* There appears no doubt that *N. treati* is congeneric with the larva of *N. oliorum* as described by Feider (1958b). The urstigma is well shown, so that there is no doubt as to its trombidoid affinities, consistent with its general appearance. Coxa I is shown well separated from coxa II, which is in agreement with the structure of *Trombella* and *Chyzeria*.

A pair of setae on the idiosomal venter, anterior to coxae I is shown by Feider (1958b, Fig. 3), which may be an error of interpretation of some fold of integument. The figures of the gnathosoma (his Figs 3, 8) show a pair of hypostomalae (palpal coxalae, or tritorostrals *sensu* Newell 1957, p. 403) level with the medial angles of the femora, which I have not been able to identify in *N. treati*, presumably because I have only the single damaged specimen available. Feider (1958b) illustrates barbed dorsal and ventral palpal femoral setae, as well as a barbed dorsal palpal genual seta, although his text omits mention of the ventral femoral seta.

#### Family Chyzeriidae

Trombellidae, Trombellinae, Trombellinae auctorum, v. sup. (ad p.).

Chyzeridae (sic) Kranz 1978, pp. 278, 304.

*Definition:* Trombidioidea in which the propodosoma of the adult and deutonymph either lacks a crista or has only a rudimentary crista, bearing a pair of sensillary setae. Eyes 2 + 2, sessile. Dorsum of idiosoma produced into a number of long processes. Idiosoma not elongate or waisted.

Larva with one dorsal scutum, with 6 setae: 2 ALs, 2 PLs and 2 sensillary setae, sensilla well separated, arising at about middle of scutum. Scutum with or without anteromedian nasus. Eyes 2 + 2, sessile. Leg segmental formula 7, 7, 7. Coxae separated. Coxal setal formula 2, 1, 1. Pedotarsal claws 3, 3, 3, the neolateral claws with widened tips. Dorsal and ventral idiosomal setae may have expanded seta bases. Supracoxalae present to gnathosoma and leg I. Lateral surface of cheliceral blades with many fine teeth. Parasitic on Orthoptera.

Type genus *Chyzeria* Canestrini, 1897.

*Remarks:* The two genera now included in the Chyzeriidae may be separated as in the following key:

#### *Key to the genera of the Chyzeriidae*

- Dorsal scutum without nasus. Palpal tarsalae may be variously modified with setules, but not long and feather-like. . . . . *Chyzeria* Canestrini

Fig. 1. *Nothrotrombidium treati* sp. nov., larva, Holotype. A Dorsal view, legs omitted beyond trochanters. pdc podocephalic canal. B Dorsal view of tip of right palp. C-E Idiosomal setae. C posterior dorsal idiosomala. D ventral idiosomal seta of first row behind coxae III. E posterior ventral idiosomala. (All figures to nearest scale.)

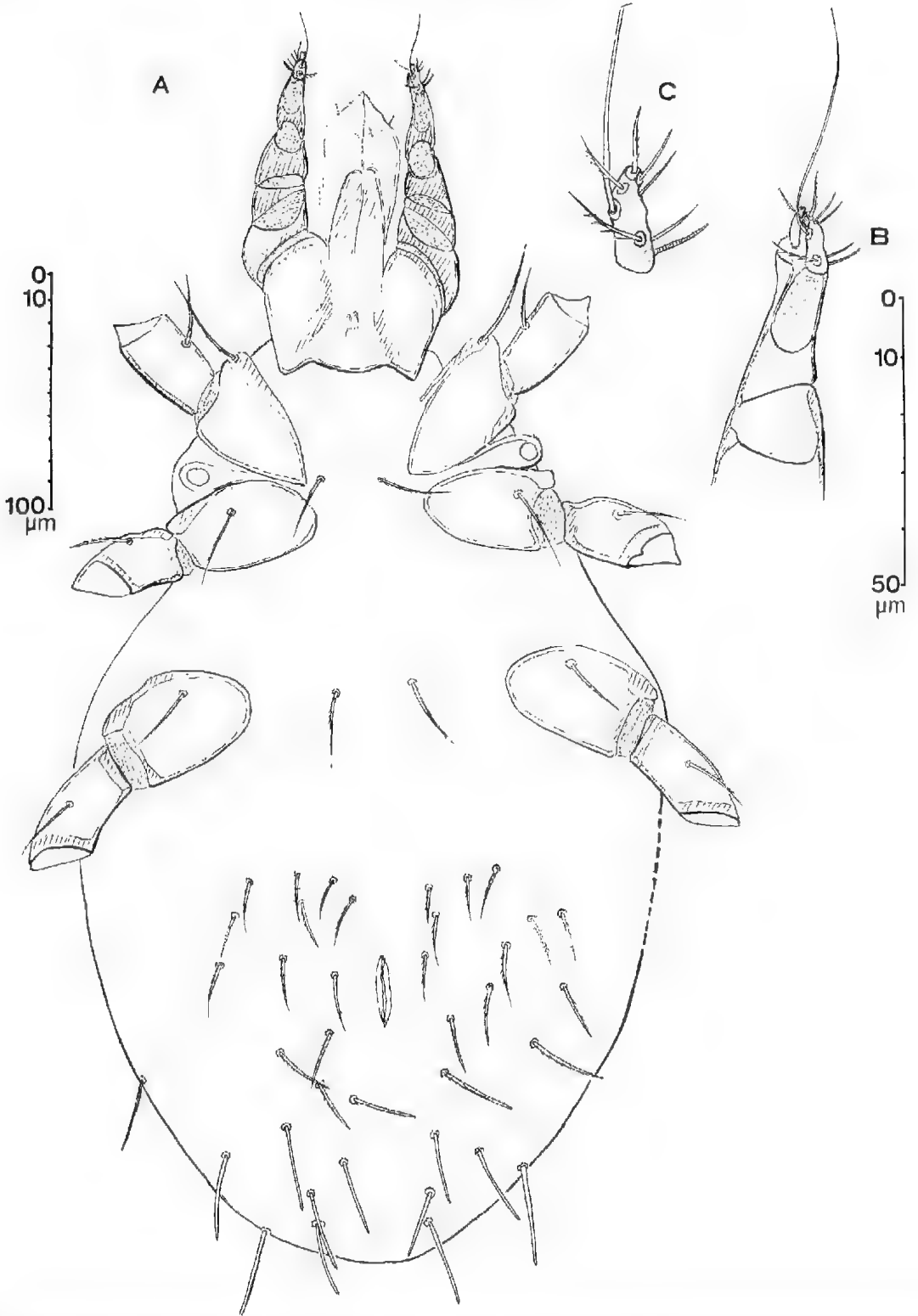
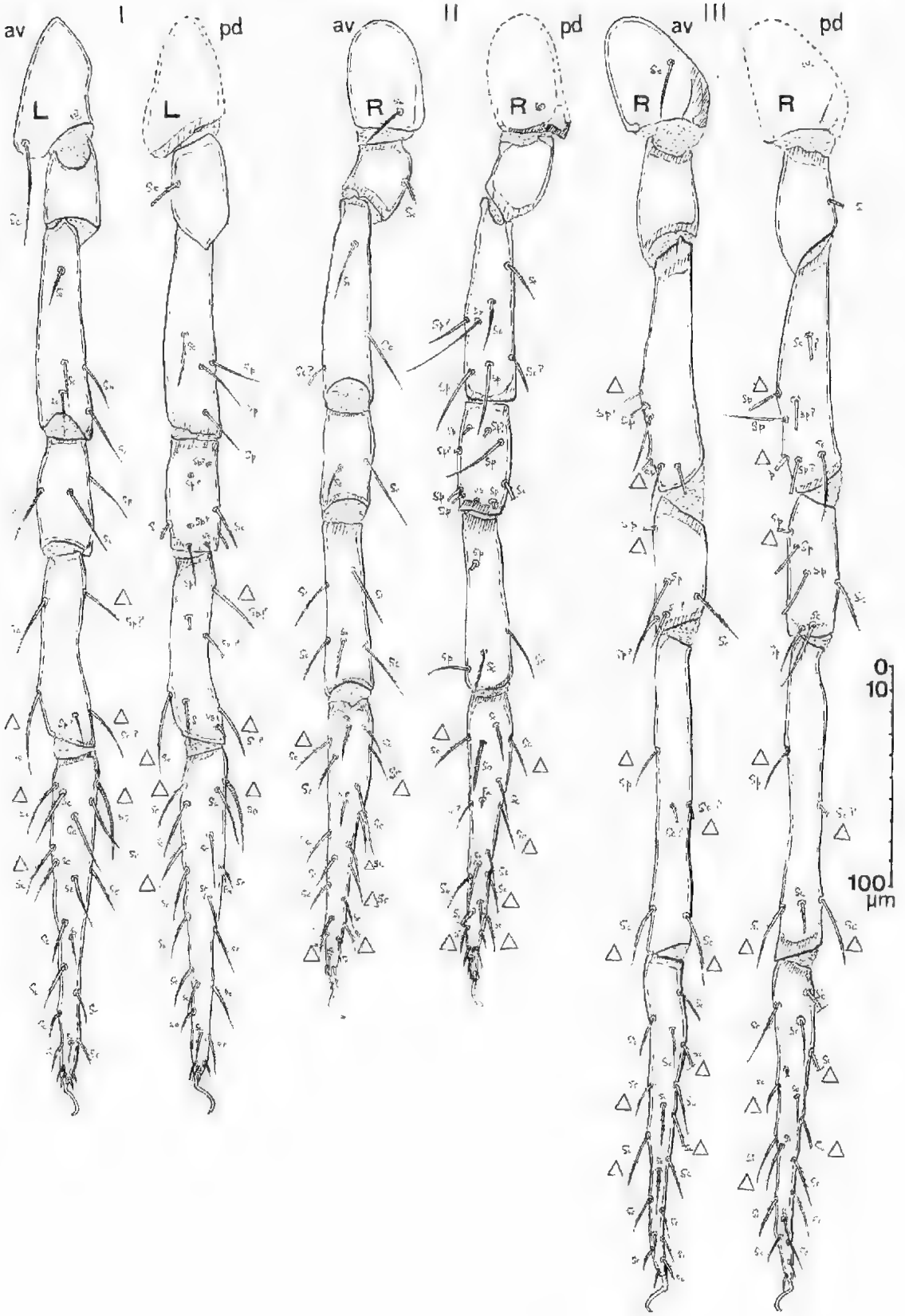


Fig. 2. *Nothrotrombidium treati* sp. nov., larva, Holotype. A Ventral view, legs omitted beyond trochanters, to scale on left. B Ventral view of right palp, to scale on right. C Further enlargement of tarsus of right palp, not to scale.

Fig. 3. *Nothrotrombidium treati* sp. nov., larva, Holotype. Legs I, II, III. Codes: L of left side, R of right side. av anterovenral. pd posterodorsal. Sc scobala (normal type seta), So solenoidata, Sp spinala (eupathidata), Vs vestigiala. Symbol Δ means that the seta is shown doubly, in both aspects for the leg. (All figures to same scale.)





Dorsal scutum with a prominent narrow nasus extending abruptly from anterior border. Some palpal tarsalae long and feather-like ..... *Nothotrombicula* Dumbleton

Audyaniidae fam. nov.

**Definition:** Trombidioidea in which the deutonymphs (adults are as yet unknown) lack a crista. Large dorsal propodosomal shield present, with anterior notch; two sensilla at posterior edge of shield, well separated. Idiosomal setae with annulus produced to form a high papilla bearing a small scobala at its tip, arranged in groups of 2-12 on small plates of the idiosoma. Similar setae on propodosomal shield and legs. Eyes absent. Palp with strong tibial claw, ctenidium present on palpal tibia as two dorsal spines. Palpal tarsus clavate, moderately enlarged. Genital valves each with single large, oval acetabulum.

Larva with single prodorsal scutum, with 8 setae: 2 AMs, short, clavate, 2 similar ALs close to the sensilla, 2 normal PLs, sensilla present behind middle of scutum, sensillary setae pointed, somewhat thickened. Nasus lacking to scutum. Eyes absent. Leg segmental formula 7, 6, 6. Coxae separated. Coxal setal formula 2, 1, 1; coxalae II and III clavate, similar to AM and AL scutalae; palpal femorala similar. Tarsal claws 2, 2, 2. Supracoxalae absent.

Content: *Audyana* Womersley, 1954a.

Johnstonianidae family group

Family Johnstonianidae

Partial synonymy

Johnstonianinae Thor 1935, p. 108; Womersley 1937, p. 76; Thor & Willmann 1947, p. 221; Feider 1955a, p. 75. Johnstonianidae Newell 1957, p. 396; 1960, p. 156; Feider 1959b, p. 540; 1979, p. 420 (also Johnstonianoidea), Vercammen-Grandjean 1972, p. 227; 1973, p. 110; Robaux 1973, p. 121; Vercammen-Grandjean *et al.* 1974, p. 245.

**Definition:** Adults: Small or middle-sized trombidioids with or without propodosomal dorsal crista. Propodosoma with one or two pairs of specialized or relatively unspecialized sensory setae, which may be set in trichobothrial pits or be less clearly defined. Eyes 2 + 2 or lacking; if present, on short peduncles. Skin comparatively smooth, without prominences or large sclerotized areas. Idiosomal setae simple, nude or, if setulose, not elaborately so; they commonly originate on small plates or raised papillae. Genital acetabula 3 + 3 or 2 + 2. Pedotarsal claws without empodium or empodium-like brush. Palp generally long and thin, with or without tibial claw, with few or no accessory spines. Paragenital sclerites present or absent.

Predatory, may be associated with semiaquatic environments.

**Larvae:** Propodosomal dorsal scutum with two pairs of sensory setae and four normal setae, or with two pairs of setae, one pair sensory and the other pair normal; sensory setae may be rudimentary or fully developed in trichobothrial pits. Leg segmental formula 7, 7, 7 or 7, 7, 6 or 6, 6, 6. Coxal setal formula 2, 2, 3-4 or 2, 1, 2 or 2, 1, 1 or 1, 1, 1. Coxal setae setulose, not highly modified. Pedotarsal claws 3, 3, 3 or 2, 2, 2. Eyes 2 + 2, sessile, or absent. Supracoxalae present or absent.

Free-living predators or ectoparasitic on insects, at times semiaquatic

Type genus *Johnstoniana* George, 1909.

**Remarks:** Thor (1935) defined the subfamily Johnstonianinae as (translation by author):

"Body (abdomen) cylindrical, with pointed, simple hairs. Crista well developed, with two areolae in the middle (or one distal) and four (= two pairs) of sensory setae. Anterior to the thorax is an elongate triangular projection (nasus). Eyes on short peduncles (kurzgestielt). Palpi almost without, or with few, spines. Legs of middling length.

Type: *Johnstoniana* C. F. George, 1909 (syn. *Diplothrombium* Berlese, 1910 = *Rohaultia* Oudemans, 1911".

Other genera placed in this subfamily by Thor & Willmann (1947) were: *Centrotrombidium* Kramer, 1896, *Diplothrombium* Berlese, 1910 (they did not accept its synonymy with *Johnstoniana*), *Myrmicotrombium* Womersley, 1934, and *Hirstithrombium* Oudemans, 1947, the last-named with type species *Diplothrombium australiense* Hirst, 1928. They removed *Nothotrombium* Storkán, 1934 in a separate, new subfamily, *Nothotrombiinae*.

*Myrmicotrombium* was shown by Southcott (1957a) to belong to the Erythracidae.

All of the genera listed were based on the adults, except for *Rohaultia*, which was considered to be a larva of *Johnstoniana* (although this has been widely accepted, Cooreman (1949, p. 10) pointed out there was no certainty that *Rohaultia hiungulum* Oudemans, 1911 was the larva of *Rhyncholophus errans* Johnston, and in fact *Rohaultia* was not established to be a larval synonym of *Johnstoniana* until Feider recorded and described the rearing of larvae of *Johnstoniana maxima* Feider, 1955 (Feider 1955a, 1958a)). Robaux (1970) described larvae of *J. errans* obtained by experimental rearing.

Further genera which have been placed in the Johnstonianidae are (see Vercammen-Grandjean 1973): *Polydiscia* Methlagl, 1928 (larva), *Parawenhaekia* Paoli, 1937 (larva), *Crossotrombium* Womersley, 1939 (adult),

*Lassenia* Newell, 1957 (larva, deutonymph, adult), *Marcandrella* Feider, 1957 (adult, deutonymph), *Charadracarus* Newell, 1960 (adult, larva), *Pteridopus* Newell & Vercammen-Grandjean, 1964 (larva), *Paraplothrombium* Robaux, 1968 (adult), *Parachyzeria* Hirst, 1926 (adult) was placed in the Johnstonianidae by Southcott (1986a). Two further genera placed in the Johnstonianidae by Vercammen-Grandjean (1973) were *Nothotrombicula* and *Grossia* (= *Chyzeria*). Both of these genera have been placed here in the Chyzeriidae. *Parawenhoekia* is excluded, as of doubtful affinity (see Southcott 1961a).

There remains a total of nine genera in the Johnstonianidae, known as larvae, for which the following subfamily groupings are proposed:

Johnstonianinae: *Johnstoniana* (= *Rohaultia*), *Diplothrombium*, *Centrotrombidium*; Tetrathrombiinae: *Tetrathrombium*; Lasseniinae: *Lassenia*; Polydisciinae: *Polydiscus*; Pteridopodinae: *Pteridopus*; Ralphaudyninae: *Ralphaudyna*; Charadracarinae: *Charadracarus*.

The following is a key to the subfamilies of the Johnstonianidae (larvae).

*Key to the larvae in the subfamilies of Johnstonianidae*

1. Tarsal claws 2, 2, 2. Anal sclerites absent. Supracoxalae absent to gnathosoma and leg I.....2  
Tarsal claws 3, 3, 3. Anal sclerites present .....3
2. Leg segmental formula 7, 7, 7 or 6, 6, 6. Posterior sensillary setae of prodorsal scutum without thickened central part to shaft, filiform (except in *Centrotrombidium* where the sensillary setae are terminally clavate). Sternal setae: usually a pair of setae between coxae III. Terminal seta of palpal tarsus not eupathidiform. Urstigma between coxae I and II not projecting away laterally from idiosoma. Coxal formula 2, 1, 1. Eyes 2 + 2. Tracheae absent. Anterior hypostomala absent ..... Johnstonianinae Thor  
Leg segmental formula 7, 7, 6. Posterior sensillary setae of prodorsal scutum with thickened part in middle. Sternal setae numerous in area between coxae II and III. Urstigma in a chitinous extension projecting well lateral from idiosoma. Coxal formula 2, 1, 2. Eyes absent. Tracheae present. Anterior hypostomala absent. Terminal setae of palpal tarsus not eupathidiform ; ; ; ..... Charadracarinae Newell
3. Leg segmental formula 6, 6, 6. Coxal setal formula 2, 1, 2 or 2, 2, 3-4. Eyes 2 + 2. Anterior sensillary setae borne on a small sclerite which may be separated from the main body of prodorsal scutum. Sternal setae absent. A well-developed pore of a "Lassenus" or "*Lassenia* organ" present upon a small separate sclerite anterior to coxa III. Supracoxalae present. .... Lasseniinae Newell  
Leg segmental formula 7, 7, 7. Eyes 2 + 2 .....4
4. Anterior scutal sensilla in anterior third of prodorsal scutum, posterior scutal sensilla in posterior third. Sternal setae absent. Coxal setal formula 2, 1, 1. .... Tetrathrombiinae subfam. nov.

- Anterior and posterior pairs of scutal sensilla both in anterior two-thirds of prodorsal scutum .....5
5. Coxal setal formula 2, 1, 2. Sternal setae lacking. Neolateral claws of pedotarsi divided. Gnathosomal supracoxalae present. .... Polydisciinae Vercammen-Grandjean  
Coxal setal formula 2, 1, 1. Two sternal setae present between coxae III. Neolateral claws of pedotarsi broadened but undivided. Supracoxalae present 6
6. Anterior sensilla of prodorsal scutum posterior to level of AL setae. Both pairs of scutal sensilla well developed. Scutum with small nasus. Coxalae normal, setulose. Tarsus III extremely elongate and carrying a dorsal row of long, feathered setae ..... Pteridopodinae subfam. nov.  
Anterior sensilla of prodorsal scutum anterior to level of AL setae. Anterior sensilla and setae significantly smaller than posterior. Scutum with large nasus. Coxal setae tuberculate with a subterminal bristle. Tarsus III spindle-shaped, only moderately elongated, and not carrying a row of feathered setae ..... Ralphaudyninae subfam. nov.

*Remarks:* All subfamilies are known from only one genus, except Johnstonianinae.

Subfamily Johnstonianinae Thor

Johnstonianinae auct. (ad p., v. sup.)

*Definition (larvae):* Prodorsal scutum with eight or four setae; if with eight then these are two pairs of each of sensillary setae and non-sensillary setae, if with four then with one pair of sensillary and one pair of nonsensillary setae. If with four setae then sensillary setae clavate; if with eight setae then sensillary setae filiform, and anterior pair may be reduced. Eyes 2 + 2, each lateral pair on a small ocular plate, which may be elevated into a tubercle; in *Centrotrombidium* posterior cornea may be obsolete or lacking. Usually two sternal setae between coxae III. Anal sclerites absent or weak; if the latter, they are non-setiferous. Coxalae 2, 1, 1; medial coxala I generally on a small pars medialis coxae, which is rarely separated from coxa. Urstigma between coxae I and II, not projecting away laterally from coxae. Pedotarsal claws 2, 2, 2. Galeala present, anterior hypostomala present, reduced or absent, posterior hypostomala present. Palpal tibial claw bifurcate. Terminal seta of palpal tarsus not eupathidiform. Tracheae absent. Supracoxalae absent.

Type genus *Johnstoniana* George, 1909.

*Remarks:* The following is a key to the genera of the larval Johnstonianinae:

*Key to genera of larval Johnstonianinae*

1. Scutum with four setae, posterior pair clavate sensillary setae. Vs absent all legs. .... *Centrotrombidium* Kramel, 1896  
Scutum with eight setae (two pairs sensillary, two pairs non-sensillary), sensillary setae not clavate .....2

2. Anterior pair of scutal sensillary setae at least one third as long as the posterior pair. VsGel.II present, VsTII, II, III absent. Anterior wall of palpal trochanter not fenestrated . . . . .  
 . . . . . *Johnstoniana* George (= *Rohaultia* Ouds.)  
 Anterior pair of scutal sensillary setae reduced, at most one sixth as long as posterior pair. Vs absent all segments. Anterior wall of palpal trochanter may be fenestrated . . . . . *Diplothrombium* Berlese, 1910.

The key above has been drawn up principally from descriptions of larvae allotted to those genera as follows: *Johnstoniana* from *J. latiscuta* Newell, 1957, *J. maxima* Feider, 1955 (described by Feider 1958a), *J. harghitenis* Feider, 1958c, *J. ventripilosa* Feider, 1958c, *J. errans* (described by Robaux 1970); *Diplothrombium monoense* and *D. cascadeense* of Newell (1957), *D. moldavicum* Feider, 1959a, *D. newelli* Robaux, 1977; *Centrotrombidium* from *C. distans* of Newell (1957), *C. romaniense* of Vercammen-Grandjean & Feider, 1973, *C. dichotomocoxala* Vercammen-Grandjean & Cochrane, 1974.

#### Tetrathrombiinae subfam. nov.

**Definition (larvae):** Anterior pair of sensilla in anterior third of prodorsal scutum, posterior pair in posterior third. Sensilla well-developed, sensillary setae filiform. Eyes 2 + 2. Sternalae absent. Coxae separated. Urstigma attached to anterior border of coxa II. Leg segmental formula 7, 7, 7. Coxal setal formula 2, 1, 1. Pedotarsal claws 3, 3, 3 (lateral claws may be reduced). Galeala, anterior hypostomala and posterior hypostomala present. Palpal tibial claw bifid.

Type genus *Tetrathrombium* Feider, 1955.

**Remarks:** *Tetrathrombium* is known from two species, *T. zachvatkini* Feider, 1955b (type species) and *T. macronychus* Feider & Suci, 1956, from Europe. *T. zachvatkini* was obtained as ectoparasitic upon a plecopteran, and *T. macronychus* from lipulid Diptera. The adults of the genus are unknown.

#### Lasseniinae Newell

Lasseniinae Newell 1957, p. 447; Vercammen-Grandjean 1973, p. 110.

Lassenidae (sic) Vercammen-Grandjean 1972, p. 236.

**Definition (larvae):** Anterior scutal sensillary setae borne on a small sclerite which may be separate from main body of scutum. Eyes 2 + 2. Sternal setae absent. Anal sclerites present, setiferous. Lassenus or "*Lassenia* organ" present (a small pore on a small separate sclerite anterior to coxa III). Leg segmental formula 6, 6, 6. Coxal setal formula

2, 1, 2 or 2, 2, 3-4. Coxalae setulose, (unmodified. VsGel, II present, VsTII present, VsTIII absent. Pedotarsal claws 3, 3, 3. Galeala, anterior hypostomala and posterior hypostomala present. Palpal tibial claw unidentate or bidentate. Supracoxalae present.

Type genus *Lassenia* Newell, 1957

**Remarks:** At present Lasseniinae should be restricted to one genus, *Lassenia*, known as larvae, deutonymphs and adults. Two species are known as larvae, both from North America. In neither case was there experimental correlation between larvae and octopod stages, and correlation was based purely on strong presumptive field evidence (Newell 1957). The larvae are parasitic on Diptera living in subaquatic environments.

Vercammen-Grandjean (1973) included in the "Lassenidae" *Lassenia*, *Polydiscia* Methlagl (known only as larva), and *Crossothrombium* Womersley, 1939 (known only as adult). The status of the last-named (which has 2 + 2 eyes, contrary to Womersley's description) will be considered in another paper. *Polydiscia* was made the type genus of Polydisciinae (sic) Vercammen-Grandjean by its author (1972); this subfamilial status will be retained here (see below).

#### Polydisciinae Vercammen-Grandjean

Polydisciinae (sic) Vercammen-Grandjean 1972, p. 236.

**Definition (larvae):** Dorsal propodosomal scutum well developed, with two pairs of trichobothrial setae and four non-sensillary setae. Anterior pair of sensillary setae originate anterior to AI. setae, behind slight convexity of anterior border of scutum; no defined nasus present; scutum markedly waisted. Eyes 2 + 2. Sternal setae lacking. Anal sclerites present, setiferous. Coxa I and II contiguous on each side, with urstigma between them. Leg segmental formula 7, 7, 7. Coxal setal formula 2, 1, 2; coxalae setulose, unmodified. Pedotarsal claws 3, 3, 3; empodium thin, falciform; neolateral claws divided. Dorsal eupathidala + companala present to tarsus I and II. Palpal tibial claw greatly modified, reduced to seta without hook structure. Galeala present, anterior hypostomala present, posterior hypostomala absent. Gnathosomal supracoxalae present.

Type genus *Polydiscia* Methlagl, 1928

**Remarks:** Known only for the species *P. squamata* Methlagl, 1928.

Vercammen-Grandjean (1972) gave a careful redescription of *Polydiscia squamata* Methlagl, and

TABLE 2. *Pedal scobalar formula for three species of larval johnstonianid and one dryphyphantid larval, mites.*

	<i>Lassenia lassenii</i> <sup>1</sup>			<i>Polydiscia squamata</i> <sup>1</sup>			<i>Piersigia limphila</i> <sup>1</sup>			<i>Charadracarus delitescens</i> <sup>2</sup>		
	I	II	III	I	II	III	I	II	III	I	II	III
Leg.												
Fe	10	10	10	6	7	6	7	7	6	6	8	6
Ge	8	8	8	4	4	4	4	4	4	5	4	4
Ti	16	17	15	9	9	9	9	9	9	5	5	7
Ta	50	43	40	21	21	20	18	17	17	22	17	15
Sub-totals	84	78	73	40	41	39	38	37	36	38	34	32
Totals		235			120			111			104	

<sup>1</sup>From Vercammen-Grandjean (1972), re-arranged.

<sup>2</sup>Derived from the illustrations of Newell (1960).

founded Polydisciinae on the sole genus *Polydiscia* on the grounds of:

- (1) limited size of palpotibial claw
- (2) presence of subterminala (= dorsal eupathidala) and parasubterminala (= companala to dorsal eupathidala) on tarsus II
- (3) "Tabulation of leg setae is very much like that of certain water mites . . ." and commented "Those characters seem to imply a high ancestry to this genus, as does the peculiar shape and ornamentation of the scutum, which interestingly links the Lasseniinae (sic) to the Dryphyphantidae" (Vercammen-Grandjean 1972, p. 236).

In 1973 he listed (without discussion) *Polydiscia* in the Lasseniinae (possibly due to a publication delay).

However, the grounds advanced by Vercammen-Grandjean for the separation of the Polydisciinae are worthy of discussion, as they are relevant to subfamilial classification within the Johnstonianidae. Criterion (1) is true, but by itself does not appear to be a justification for subfamilial status. Criterion (2) also applies in e.g. *Lassenia lassenii* Newell (see Newell 1957) and *L. scutellata* Newell (see Newell 1957).

Criterion (3) is of more interest, and is an expression of an increasing tendency among specialists of the prostigmatic mites to use the numbers of normal setae (scobalae) on the leg segments in higher classifications. These numbers may be expressed in a 'pedal scobalar formula', as has been done e.g. by Vercammen-Grandjean (1972), Robaux (1977). This formula, for four species of trombidiform mites, is shown in Table 2.

From Table 2 it can be seen that there is a decrease in pilosity through the four genera *Lassenia*, *Polydiscia*, *Piersigia* and *Charadracarus*. If reduction of the number of leg scobalae is considered to be derived then *Lassenia* is the most primitive of the four genera listed, and *Charadracarus* the most derived. These remarks apply only to absolute numbers of scobalae. In the case of the genera, however, *Polydiscia* has fewer setae than *Charadracarus*, at least for genu I.

On the other hand, if one considers the numbers of idiosomal scobalae, of the larvae, the relationship is reversed between *Lassenia* and *Charadracarus*. Thus *Charadracarus* larvae have a large number of setae in the intercoxal area between coxae II and III, while *Lassenia* larvae have none.

It would appear, therefore, that any conclusions about the phylogeny of the various johnstonianid subfamilies at least, based on the degree of pilosity of the larvae, should be treated with caution. Other characters must be introduced into such an analysis.

#### Pteridopodinae subfam. nov.

Pteridopiidae Feider, 1979, pp. 420, 421 (*nom. nud.*, proposed without definition or key).

**Definition (larvae):** Prodorsal scutum well-developed, with anterior nasus and eight setae; two pairs of well-developed sensilla, anterior pair originating behind level of AL scutalae. Sensillary setae setulose, not expanded, may be plumose. Eyes 2 + 2. Sternal setae: two, between coxae III. Anal sclerites present. Lassenus present. Coxae I and II contiguous or nearly so on each side, urstigma well developed. Leg segmental formula 7, 7, 7. Coxal setal formula 2, 1, 1; coxalae normal, setulose. VsGel, II, VstII present; VstIII absent. Tarsal claws 3, 3, 3; neolateral claws with distal widening. Tarsus III elongated, carrying dorsally a row of plumose setae; similar setae on tibia III. Cheliceral blades with many fine teeth and tubercles. Palpal trochanter not fenestrated; palpal tibial claw strongly bifid. Supracoxalae present.

Type genus *Pteridopus* Newell & Vercammen-Grandjean, 1964

**Remarks:** The Pteridopodinae at present contains only the genus *Pteridopus*, known for two species of larvae (adults are not known) from Africa: *P. auditor* Newell & Vercammen-Grandjean, 1964 (type species) and *P. pseudhannemania* Newell & Vercammen-Grandjean, 1964.

#### Ralphaudyninae subfam. nov.

**Definition (larvae):** Prodorsal scutum well-developed, with broad nasus; eight setae, four

sensory. Anterior pair of sensilla anterior to level of A1-scutalae, smaller than posterior pair. Sensillary setae not enlarged. Eyes 2: 1-2. Sternal setae: two, between coxae III. Anal sclerites present, setiferous. Coxae I and II contiguous on each side, with the urstigma set laterally between them. Leg segmental formula 7, 7, 7. Coxal setal formula 2, 1, 1; all coxalae modified, tubercular, with subterminal bristle in only known species. Tarsus III only moderately elongated, does not carry a row of plumose setae along dorsum. Tarsal claws 3, 3, 3; all claws widened, but undivided. Galeala, anterior and posterior hypostomalae present. Palpal tibial claw bifid. Supracoxalae present.

Type genus *Ralphaudyna* Vercammen-Grandjean *et al.*, 1974.

**Remarks:** The *Ralphaudyninae* contains only the genus *Ralphaudyna*, known only for its type species.

*Ralphaudyna* Vercammen-Grandjean *et al.*, 1974

**Definition:** With the characters of the subfamily.

*Ralphaudyna amamiensis* Vercammen-Grandjean *et al.*, 1974

**Remarks:** Through the kindness of Mr W. C. Welbourn, Acarology Laboratory, State University of Ohio, I have examined three specimens which conform to this species. Collection details are as follows:

Japan, Shikoku, Ishizuchi National Park, Omogo Uly (sic), 700 m, 18-25.viii.1980, ex *Tachyctes robustus* [Ander; Raphidophoridae, Gryllacridoidea] S. & J. Reck, codes WCW 81406-9, -2, -9; local identifications (RVS) ACB727A, B, C.

Significant morphological features have been discussed on p. 26, leading to the above taxonomic placement.

Metric data of scutum and legs of these three species are provided in Table 3.

The dorsal scutum is shown in Fig. 4C. The anterior sensilla have the typical "half-lidded" appearance of trombidoid scutal sensilla. The sternalae are between coxae III, long-conical with faint adpressed setules, 60  $\mu$ m long. The palpal tibial claws are well-cleft; the tines are separated, and in the correct orientation can be seen to be angled about half-way along their length (Fig. 4A, B).

**Remarks on biology:** The finding of larvae of this species as ectoparasites on a gryllacridoid (cave cricket) is of considerable interest. Many of the larvae of the Johnstonianidae have been taken as ectoparasites upon water associated insects, e.g. upon tipulids, or even upon the aquatic pupae of water beetles of an unnamed family (Newell 1957).

There is a superficial resemblance between *Ralphaudyna* larvae and *Chyzeria* in the highly modified coxalae of at least some species of *Chyzeria* larvae (see Southcott 1982).

#### Charadracarinae Newell

Charadracarinae Newell 1960, p. 157; Vercammen-Grandjean 1973, p. 110.

**Definition (larvae):** Anterior propodosomal dorsal scutum well-developed, with a sharp nasus and slight evidence of a crista; with eight setae; two pairs of sensillary setae, two pairs non-sensillary. Anterior pair of sensillary setae little different from scutalae, without a well-developed typical alveolar pit. Posterior sensillary setae with expanded middle part, arising from approximately normal trichobothrial pits. Ocular sclerites and eyes absent. Sternal setae numerous on venter of idiosoma in area between coxae II and III. Anal sclerites absent. Coxae I and II contiguous on each side. Urostigma well-developed, in chitinous extension on lateral side of coxa I. Leg segmental formula 7, 7, 6. Coxalae 2, 1, 2; coxalae normal, tapering, setulose. Pedotarsal claws 2, 2, 2. Galeala present, anterior hypostomala absent, posterior hypostomala present. Anterior wall of palpal trochanter not fenestrated. Terminal setae of palpal tarsus not eupathidiform. Supracoxalae absent.

Type genus *Charadracarus* Newell, 1960.

**Remarks:** Charadracarinae includes only the genus *Charadracarus*, with two species in North America, *C. hurdi* Newell, 1960 and *C. delitescens* Newell, 1960, and two European species, *C. grandjeani* (André, 1930) and *C. aelleni* (Cooreman, 1954). The larva is known only for *C. delitescens*; correlation between the larva and adult for this species appears to have been based on strong evidence of association in the field, together with the morphological similarities of the adults and larva, without evidence of experimental rearing. There is no present evidence to dispute the proposed correlation; the larva is clearly a member of the Johnstonianidae on other grounds.

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TABLE 3. *Metric data of three specimens of Ralphaudyna amamiensis larvae, in µm.*

Specimen	LN	MA	AW	PW	SB	MS	ASB	PSB	L	W	AP	AM	AL	PL
ACB727A	46	36	58	124	23	43	89	45	134	159	53	43	55	72
ACB727B	45	33	57	116	22	43	88	42	130	149	53	—	56	67
ACB727C	46	38	67	133	22	40	86	46	132	159	55	46	—	69
ACB727A	AMB	SE	DS	MDS	PDS	BFeI	TFeI	GeI	TII	TaI(L)	TaI(H)			
ACB727A	17	100	44-76	55	70	48	45	54	64	124	32			
ACB727B	18	—	38-75	38-64	64-75	49	42	48	62	116	34			
ACB727C	16	—	46 76	68	76	47	43	48	63	127	34			
ACB727A	BFeII	TFeII	GeII	TII	TaII(L)	BFeIII	TFeIII	GeIII	TIII	TaIII(L)	TaIII(H)			
ACB727A	49	49	43	53	115	55	54	42	62	144	27			
ACB727B	47	40	44	50	108	53	51	43	61	135	27			
ACB727C	45	46	45	54	115	51	53	46	62	147	25			

Note: In the above table I have used the terms customarily used for trombidid larvae with two sensilla, e.g. I have used AMB instead of SBA, LN instead of ASBA, etc., which are appropriate for a scutum with two pairs of sensilla (see Southcott, 1961a, Fig. 8, p. 398), to make these data more readily comparable with the data of Veracammen-Grandjean *et al.* (1974).

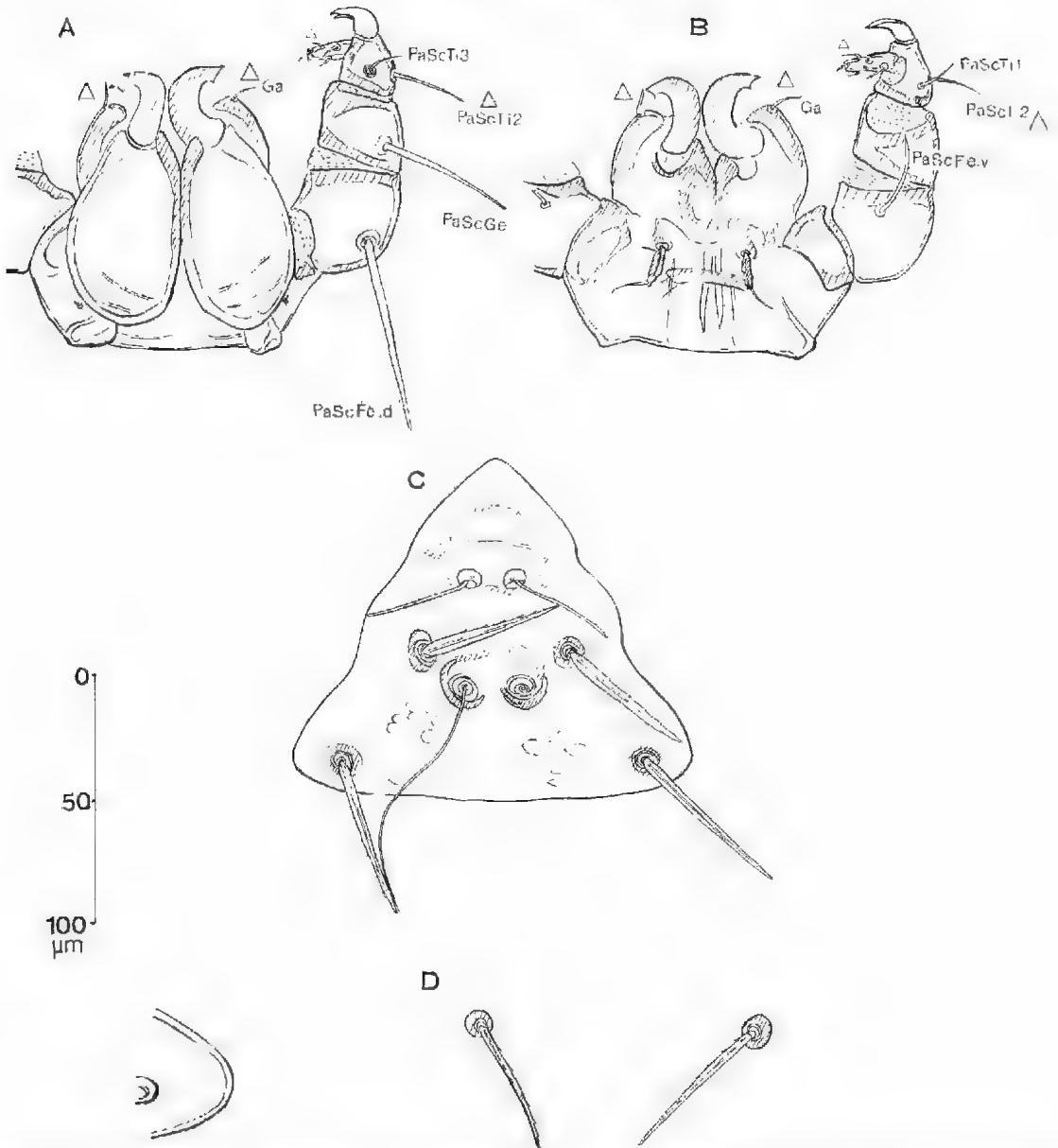


Fig. 4. *Ralphaudyna amamiensis* Vercammen-Grandean *et al.*, 1974, larva, specimen ACB727A, to standard notation. A Gnathosoma, dorsal. B Gnathosoma, ventral. C Dorsal scutum. D Part of coxa III and the two sternalae. (All to scale shown.)

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